U.S. ARMY TEST AND EVALUATION COMMAND
COMMON ENGINEERING TEST PROCEDURE

MISSILEBORNE GUIDANCE AND CONTROL SUBSYSTEM TEST

1. OBJECTIVE

The objective of this MTP is to determine the relative performance and reliability of an MBG & C unit under operational environments.

2. BACKGROUND

Laboratory testing of MBG & C subsystems is necessary to ensure proper design, performance, and continuing quality throughout production. It can be employed effectively in the investigation of problem areas and in system analysis. However, because of the infeasibility of conducting complete laboratory tests under all possible combinations of conditions, a laboratory test program is limited and must be based upon a realistic approach. The program must be tailored to the specific MBG & C subsystem to yield valid, useful, and timely information. Engineers and other personnel actively engaged in testing and evaluating MBG & C systems have developed, over a period of time, certain general procedures for testing. Properly used, these procedures can determine the acceptability of an MBG & C subsystem for an intended use. To be accepted, the subsystem must adhere to design parameters and the manufacturer's specifications. A basic requirement of the testing is to relate the results of controlled tests to the operational and flight performance of the MBG &C subsystem. Proper evaluation of the subsystem can aid in increasing the probability of success of an expensive missile flight.

3. REQUIRED EQUIPMENT

a. Organizational test and checkout equipment
b. Sensing element exercising equipment
c. Ausiliary power supplies
d. Auxiliary test and checkout equipment
c. Specialized equipment

4. REFERENCES

A. Locke, Arthur S., Guidance, D. Van Nostrand Company, Inc., Princeton, N. J., 1955.
B. Hobbs, Marvin, Basics of Missile Guidance and Space Techniques, Vol. 2, John F. Rider Publisher, Inc., New York, 1959.

5. SCOPE

5.1 SUMMARY

The test procedures outlined in this MTP are designed to detect the

limitations and other characteristics which will determine the applicability of an MBG&C subsystem to a given use, both from an operational and performance point of view.

5.1.1 Operational Subtests

The objective of the operational subtests is to determine the functionality of the MBG&C subsystem major assemblies and their associated organizational checkout equipment. Specific tests included herein are:

a. Organizational checkout equipment subtest - The objective of this subtest is to determine the accuracy of measurements made by assocaited MBG&C organizational checkout equipment.

b. MBG&C major assembly operation subtest - The objective of this subtest is to determine the functionality of each major assembly of the MBG&C subsystem, in terms of specified performance areas, during various subsystem modes of operation.

5.1.2 Performance Subtests

The objective of the performance subtests is to determine the effects of specific operational and environmental conditions on subsystem performance. This determination is made by investigating and defining the performance of the MBG&C subsystem as indicated by the operational subtests and by establishing the performance of the subsystem under conditions of noise and loading specific tests include:

a. Static performance subtest - The objective of this subtest is to determine performance capabilities and limitations of the MBG&C subsystem. This determination is based on the static testing of the subsystems major assemblies, while interconnected for the following characteristics:

1) Accuracy
2) Sensitivity
3) Dead band
4) Drift
5) Cross coupling
6) Repeatability
7) Stability
8) Response

b. Dynamic performance subtest - The objective of this subtest is to determine the performance capabilities of the MBG&C subsystem under dynamic conditions of loading and noise.

5.2 LIMITATIONS

Due to the wide variety of situations and combinations of circumstances

encountered in the field, the test considerations outlined in this MTP will be restricted to laboratory tests. The procedures outlined are merely guides, and their results are dependent upon modern, specialized facilities and skilled, experienced personnel.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Prescheduling Conditions

a. The tests outlined in this MTP shall be scheduled to be conducted under laboratory conditions at ambient temperatures and pressures.

b. Tests shall be scheduled so as to allow a comprehensive evaluation of the entire MBG&C subsystem to detect cross coupling or interaction between components. Subsequent component testing will be scheduled in order to detect and scrutinize other more deceptive elements.

6.1.2 Pretesting Conditions

a. Personnel responsible for conducting the test should ensure that the test facility will be available. Firm scheduling should be verified

b. Personnel responsible shall insure that applicable instructions and design specifications are on hand

c. Reports of previous MBG&C subsystem tests should be available where appropriate.

d. Operating instructions should be obtained for test instruments used during test conduct

e. Prepare test log book or folder for recording of data during test conduct

f. Brief test personnel on purpose of test and accuracy expected

G. Calibrate the MBG&C subsystem organizational test equipment and auxiliary test equipment to correctly measure the following functions:

1) Important impedences throughout the subsystem
2) Power supply voltages, current, and power consumption
3) References, biases, excitation, and synchronization
4) Interlock and failsafe features
5) Limiting, switching, and cutoff devices
6) Mechanical integrity (leaks, seals, etc.)
7) Power transfer
8) Starting time

6.2 TEST CONDUCT

6.2.1 Operational Subtests For the MBG&C Subsystem

6.2.1.1 Organizational Checkout Equipment Subtest

a. Arrange equipment according to Figure 1., Page 4.
b. Turn equipment on and allow sufficient time for warm-up.
c. Connect and adjust the MBG&C subsystem organizational tests and checkout equipment to measure the functions listed in 6.1.2.G.
d. Record the readings measured in c., above by the organizational test equipment.
e. With the organizational test and checkout equipment connected as in c., above, measure and record the go/no-go condition of each listed function.

NOTE: The organizational test and checkout equipment usually is limited to a go/no-go type circuit, displaying various conditions in the form of lights or a colored area on a metered dial

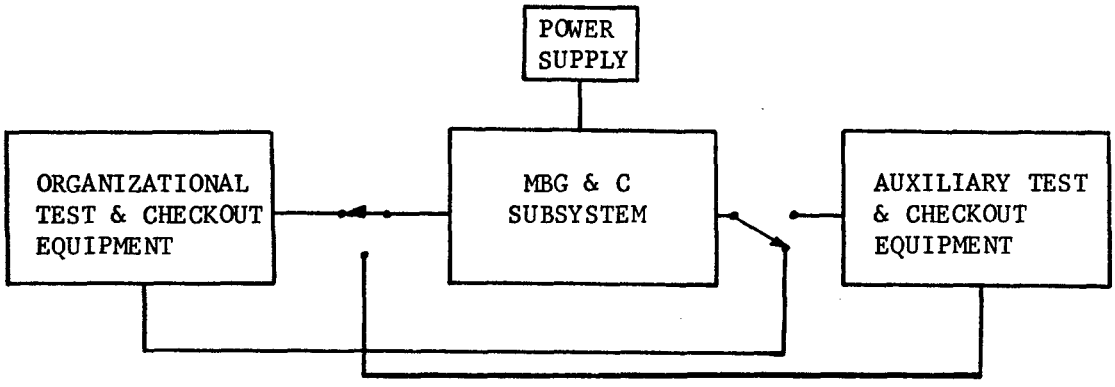

Figure 1. Setup for Organizational Test and Checkout Equipment Subtest and the MBG&C Major Assembly Operation Subtest.

f. Connect and adjust auxiliary special test equipment to measure each of the functions measured by the organizational test and checkout equipment.
g. Record the values measured by the auxiliary test equipment.

NOTE: The auxiliary test equipment used during this test shall be

calibrated prior to testing and capable of more precision than the organizational test and checkout equipment. Data supplied by auxiliary equipment measured above is used to determine the functionality of the organizational equipment.

6.2.1.2 MBG&C Major Assembly Operation Subtest

a. Connect equipment according to Figure 2., Page 6.
b. Turn on equipment and allow sufficient time for warm-up.
c. Adjust the MBG&C test subsystem until all functions listed in 6.1.2.,g, are in the "go" condition (functionality status obtained by monitoring organizational equipment).
d. Verify the above measurements with auxiliary test equipment.
e. Utilizing the organizational test equipment, measure the performance of each major assembly of the test subsystem during the below listed modes of operation for each listed performance area.

Modes of Operation	Performance Areas
Pre-launch	Static Accuracy
Power changeover (external or internal)	Reference levels
Boost	Starting characteristics
Midcourse	Alignment drift & adjustment
Terminal	Signal flow & switching functions gain, sensitivity and response. Basic functions of sensing elements

f. Record the response of each subassembly of the test subsystem during each mode of operation and for each performance area listed above.

6.2.2 Performance Subtests for the MBG&C Subsystem

6.2.2.1 Static Performance Subtest

a. Connect equipment as shown in Figure 2, Page 6.
b. Turn equipment on and allow for warm-up.
c. Using the organizational checkout equipment, measure the test subsystem's response to simulated input signals in terms of each of the characteristics listed below:

1) Accuracy
2) Sensitivity
3) Dead Band
4) Drift
5) Cross Coupling
6) Repeatability

7) Stability
8) Response

NOTE: Auxiliary test equipment may be used during this test if required

d. Record values measured for each characteristic above.

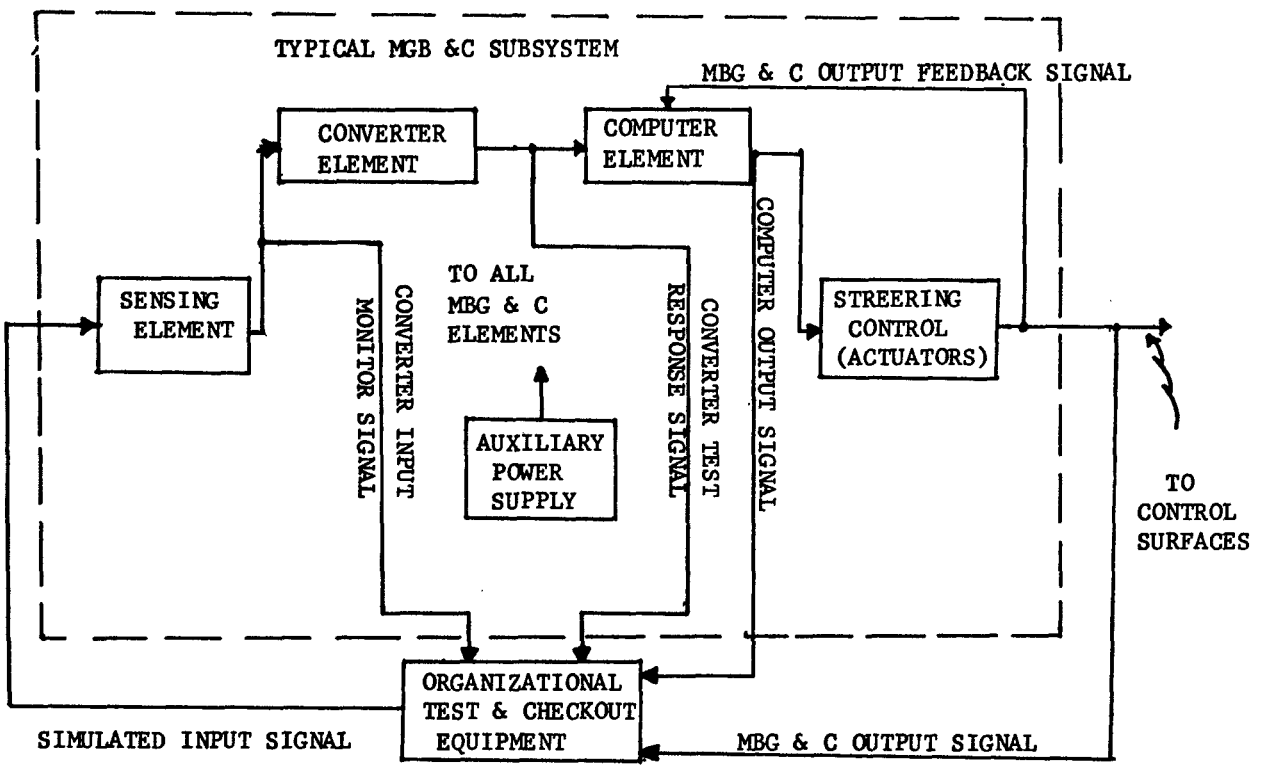

Figure 2. Arrangement for Measuring the Operation of MBG & C Major Assemblies and the Performance of the Subsystem Under Static Conditions.

6.2.2.2 Dynamic Performance Subtest

a. Connect equipment as shown in Figure 3, Page 7.

b. Turn equipment on and allow for warm-up

c. Using the organizational test and checkout equipment, monitor the test sybsystems response to simulated input signals in terms of each of the characteristics listed in 6.2.2.1, above while the test subsystem is under load. Record measured response.

d. Repeat procedures of c., above while the subsystem is functioning in an environment with a high electronic noise level.

e. Repeat procedures of c., above after replacing each subsystem major assembly with a marginal component.

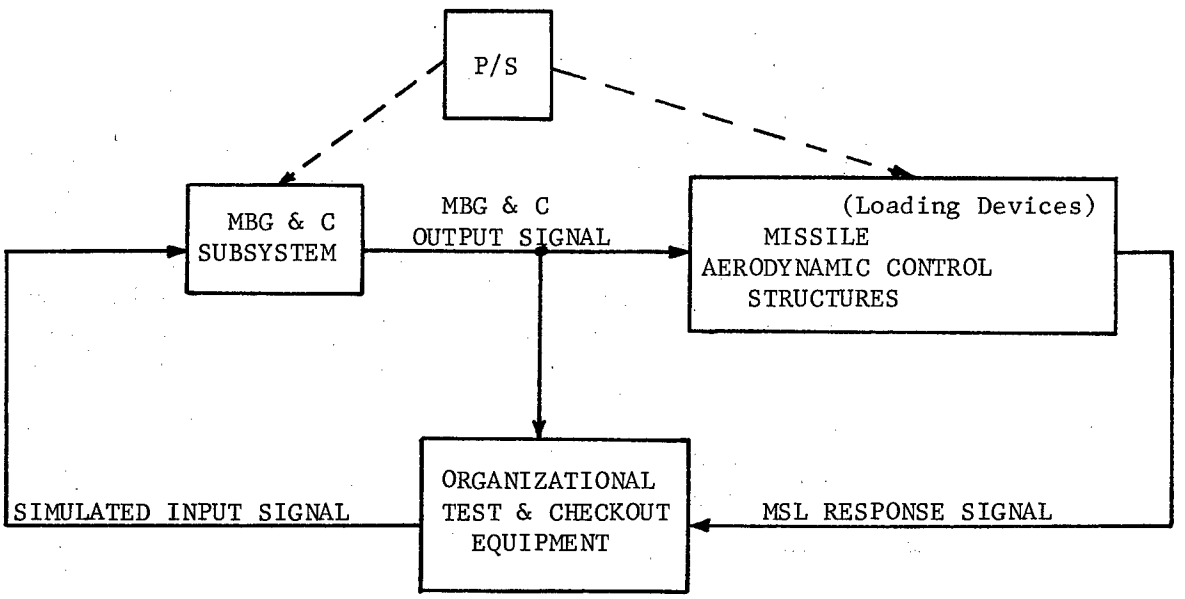

Figure 3. Arrangement for Measuring the Performance of the MBG&C Subsystem Under Dynamic Conditions.

NOTE: The procedures in c., above must be repeated each time a subassembly is replaced. Only one marginal component shall be inserted for any one repetition.

6.3 TEST DATA

6.3.1 Operational Subtest for the MBG&C Subsystem Data

6.3.1.1 Organizational Checkout Equipment Subtest Data

a. Record the readings in 6.2.1.1,c, measured by the organizational test equipment.
b. Record the go/no-go condition of functions listed in 6.2.3,g, and measured in 6.2.1.1,e.
c. Record the values measured by the auxiliary test equipment.

6.3.1.2 MBG&C Major Assemblies Operational Subtest Data

Record the response of each subassembly of the test subsystem during each operational mode and for each performance area listed in 6.2.1.2, e.

6.3.2 Performance Performance Subtest Data

Record values measured by the organizational test and checkout equipment for each characteristic listed in 6.2.2.1, c.

6.3.2.2 Dynamic Performance Subtest Data

a. Record the test sybsystem's response to simulated signals in terms of the characteristics listed in 6.2.2.1, c., while the test subsystem is under load.
b. Record the test subsystem's response to simulated signals in terms of the characteristics listed in 6.2.2.1, c., while the test subsystem is in an environment with a high electronic noise level.
c. Record the response of the subsystem under test to simulated signals in terms of the characteristics listed in 6.2.2.1,c., after replacing each major assembly of the test subsystem with a marginally functional component.

6.4. DATA REDUCTION AND PRESENTATION

6.4.1 Operational Subtest Data Reduction and Presentation

6.4.1.1 Organizational Test and Checkout Equipment Subtest Data

6.4.1.1.1 Data Reduction

a. Compare readings taken by the organizational test and checkout equipment and recorded in 6.3.1.1, c., after the comparison, compute the % of error between the two groups of measurements as follows:

$$\% \text{ Error} = \frac{Ro - Ra}{Ra} \times 100$$

Where: Ra = Reading from auxiliary equipment
Ro = Reading from orgainzational equipment

b. Compare the go/no-go readings taken by the organizational test and checkout equipment and recorded in 6.3.1.1, b., with the actual numerical values taken by the auxiliary test equipment and recorded in 6.3.1.1, c., and determine whether the go/no-go condition recorded reflects the status of the test subsystem in terms of the corresponding reading taken by the auxiliary test equipment.

6.4.1.1.2 Data Presentation

a. Present data reduced in 6.4.1.1.1, a., according to the chart shown in Figure 4, Page 10.
b. Present data reduced in 6.4.1.1.1, b., according to the chart shown in Figure 5, Page 11.

6.4.1.2 MBG&C Major Assemblies Subtest Data

6.4.1.2.1 Data Reduction (MGB&C Major Assemblies Subtest Data)

a. Compare the values obtained from the organizational test and checkout equipment in 6.2.1.2, with the values specified as desirable for the major assemblies of the subsystem under test, during each operational mode
b. Compute the % error between measured and specified values as follows:

$$\% \text{ Error} = \frac{Ro - Rs}{Rs} \times 100$$

Where: Ro = Reading obtained from organizational equipment
Rs = System specified value

NOTE: For go/no-go readings, omit % error calculation and present unreduced value.

6.4.1.2.2 Data Presentation (MBG&C Major Assemblies Subtest Data)

Present data from the preceding section in tabular form according to the chart shown in Figure 6, Page 12.

6.4.2 Performance Subtests Data Reduction And Presentation

6.4.2.1 Static Performance Subtest Data Reduction and Presentation

6.4.2.1.1 Data Reduction (Static Performance Data)

a. Compare the values obtained for measured characteristics of the MBG&C subsystem in 6.2.2.1, c., with values specified as desirable for the MBG&C subsystem under test.

b. Compute the % error between measured and specified values as follows:

$$\% \text{ Error} = \frac{Ro - Rs}{Rs} \times 100$$

(Ro and Rs defined in 6.4.1.2.1, b.)

6.4.2.1.2 Data Presentation (Static Performance)

Present data from the preceding section according to chart shown in Figure 7., Page 13.

6.4.2.2 Dynamic Performance Subtest Data Reduction Presentation

6.4.2.2.1 Data Reduction (Dynamic Performance Data)

a. Compare the values obtained for the measured characteristics with prescribed desirable values, of the MBG&C subsystem in 6.2.2.1, c., while the test subsystem is under load, in an environment of high electronic noise and after replacing each major assembly of the test subsystem with a marginally functional component.

b. Compute the % error between recorded measured values and prescribed values as indicated in 6.4.1.1.1, a.

6.4.2.2.2 Data Presentation (Dynamic Performance Data)

Present data from the preceding section on a chart similar to the chart shown in Figure 7., Page 13.

Test Item				
	Testing Conditions			
Functions to be tested	Data from organizational test equipment	Data from auxiliary test equipment	% Error	Comments
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Figure 4. Organizational Test and Checkout Equipment Subtest Data

Test Item____

Testing Conditions_____

Functions to be tested	Go/No Go Data from organizational test equipment	Data from auxiliary test equipment	Go/No Go Validity	Comments
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Figure 5. Organizational Test and Checkout Equipment Go/No Go Subtest Data

Test Item_____

Testing Conditions_____

Performance area to be tested	Data from organizational test equipment	Value specified for test item	% Error	Go/No Go Status
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Figure 6. MBG & C Major Assembly Operational Subtest Data

Test Item____

Testing Conditions_____

Characteristic to be tested	Data from test equipment	Value specified for test item	% Error	Go/No Go Status
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Figure 7. Performance Test Data